Consumer and Corporate Affairs Canada
Consommation et Corporations Canada

(11) (A) No 1 217 386

(45) ISSUED 870203

(52) CLASS 103-30

(51) INT. CL. [4] F04B 43/00

(19) (CA) CANADIAN PATENT (12)

(54) Pump

(72) Zelenka, Frank,
Canada

(21) APPLICATION No. 460,902

(22) FILED 840813

No. OF CLAIMS 10

460102

ROGERS BERESKIN & PARR CANADA

TITLE: PUMP

ABSTRACT OF THE DISCLOSURE

This invention involves a pump for pumping concrete and the like. The pump comprises a flexible tube through which the material to be pumped may travel. The material to be pumped is caused to move along the tube by a series of means which squeeze the tube to displace the fluid being conveyed. Successive squeezing means are sequentially operated to cause a sequential squeezing of adjacent portions of the conduit to force the material along. The squeezing means may include air inflated bladders which surround the conduit and operate to squeeze the conduit against the resistance of backing plates.

This invention relates to pumps for pumping flowable substances such as concrete and the like through a conduit.

Freshly manufactured concrete is a relatively thick but flowable substance which can be moved by pump. Typically a concrete pump comprises an auger or like feed system which develops sufficient pressure to force the mixture through a conduit. By virtue of the weight of the concrete a very substantial head is obtained when attempting to pump the concrete upwardly such as to upper level floors at a building construction site. Concrete can also be elevated to an upper level in a building site by use of a belt conveyor or the like. However, concrete is a mixture of sand, water, cement and various types of aggregate and unfortunately will separate if subjected to vibration. Accordingly, regulations exist for the distances over which concrete may be conveyed on such vibrating type apparatus.

In view of the substantial weight of concrete and in view of the problems involving separation of concrete there has been heretofore a relatively limited vertical head over which concrete may be transported by pumping action. This has usually been in the order of a few stories in height. When concrete is required at a distance greater than a few stories from the preparation or delivery area, concrete is usually transported by

means of buckets and construction cranes or the like.

Certain types of highly corrosive liquids cannot be routinely handled by pumps having any form of practical impeller. Where a highly corrosive material is to be handled and no suitable impeller material exists, the material must be pumped without contacting an impeller directly. In order to handle such materials pumps known as "tube pumps" have been created. Tube pumps are particularly useful for handling highly corrosive materials and also for handling liquids which must remain sterile or free from contamination such as the pumping of human blood and the like. Tube pumps usually comprise a U-shaped loop of flexible conduit conduit contained within a U-shaped housing. Within the housing there is provided a central shaft to which is attached a bar having a pair of rollers journalled at each end of the bar. As the shaft rotates the bar rotates and the rollers at each end of the bar progressively squeeze the tubing. With such pumps a block of fluid is moved through the pump from one side of the housing to the other.

Tube pumps have proven particularly well suited to handling readily flowable material such as human bodily fluids and corrosive chemical liquids. The tube pump however provides a system in which the entire pumping head is generated within the U-shaped body of the pump. While such a pump is useful for a relatively

light fluid of the weight of water such a pump would not be practically usable for generating sufficiently high heads to pump concrete through any appreciable height or through any appreciable length of conduit.

According to the present invention a pump is provided which is suitable for pumping liquids such as concrete. The pump is also suitable for pumping any form of liquid or flowable material through a flexible conduit. The pump comprises a flexible conduit extending from inlet to outlet. Means are provided to squeeze the flexible conduit in sequence such that the squeezing means forces the flowable material or fluid within the conduit along the conduit.

According to an embodiment of the invention, the pump comprises a flexible conduit having a plurality of means to squeeze the conduit. The pump is provided with an initiation means to cause a first squeezing means to squeeze the conduit. Sequencing means are provided to progressively cause adjacent squeezing means to commence squeezing of the conduit thereby forcing fluid or flowable material along the conduit. The sequencing means also cause the squeezing means to release the conduit in sequence so as to be ready to pass a second quantity of material along the conduit. As each squeezing means only displaces the flowable material or liquid from the area being squeezed and the flowable material or liquid is otherwise not hydraulically linked to any

of the other material in the conduit, each squeezing means must generate only sufficient force to move the material out of the area being squeezed. In this manner each squeezing means need not overcome the effect of hydraulic head for material which is down stream of any particular squeezing means. With such a pump there is no theoretical limit to the height to which any material may be pumped provided that a squeezing means is provided along the length of the pump.

In a preferred embodiment of the invention the squeezing means comprises a plurality of bladders which surround the flexible conduit. Fluid, either liquid or gaseous, is pumped into the bladders to cause squeezing or collapsing of the flexible conduit so as to force material through the conduit. The bladder may be supported externally so that inflation of the bladder with fluid causes the flexible conduit to collapse. The sequencing means can conclude valve means which causes the plurality of bladders arranged along a conduit to successively inflate and collapse the flexible conduit, thereby forcing material along the conduit. While various valving means can be used to accomplish the sequential squeezing of the flexible conduit one particularly useful embodiment includes a control valve for each such bladder and an initiation valve to commence operation.

Pumps manufactured in accordance with the present invention may be made of a convenient length and

strung together to accommodate any distance or height through which the material to be pumped may be moved.

The invention will be better understood by reference to the following drawings illustrating a preferred embodiment of the invention and in which:

Figure 1 is a schematic drawing of a pump according to the invention being used on a building of substantial height;

Figure 2 is a partially section of a segment of the pump of Figure 1 illustrating the arrangement of a plurality of squeezing means arranged along a flexible conduit;

Figure 3 illustrates the construction of a single squeezing means of the pump of Figure 2 with fluid hoses removed;

Figure 4 is the horizontal section through the squeezing means of Figure 4 taken along lines 4-4 of Figure 3;

Figure 5 is a vertical section through a control valve as illustrated in Figure 2 for use in association with the squeezing means of Figures 3 and 4 and illustrating the spool valve at one limit of its travel;

Figure 6 is a view similar to Figure 5 of the valve showing the spool valve at the other limit of its travel;

Figure 7 is a schematic logic diagram illustrating the tubing interconnecting the control valves and

squeezing means of a segment of pipe illustrating the sequential operation of the squeezing means along the length of conduit.

In Figure 1 the pump 10 comprises a plurality of sections 12. Concrete flows from a hopper or tank 14 into the pump 10. The building is illustrated in simple outline showing a building at the steel erection stage and assuming that concrete is to be supplied to an upper floor. The pump 10 may be supported by the building by means of a series of suitable support plates 18 arranged at suitable height along the edge of the building. Alternate support means may also be used and will be discussed in greater detail below.

Figure 2 illustrates a single section 12 of the pump. The section 12 comprises an outer casing 20 extending between two flanges 22 and 24. The casing flanges 22 and 24 are provided with a series of bolt holes to receive bolts by means of which successive sections 12 may be coupled together. In Figure 2 lower casing flange 24 is shown bolted to the tank 14 from which the pump receives freshly deposited concrete.

The section 12 comprises an inner flexible conduit 26. The flexible conduit 26 is attached to a tank outlet pipe 28 by means of a clamp 30. The flexible conduit 26 is advantageously made of a natural rubber interior sheathing, reinforcement and neoprene outer sheathing construction known as breaded hose.

Arranged along the length of the section are a plurality of sleeves 40. Two such sleeves 40 are illustrated in Figure 2. It will be appreciated that the section 12 may be manufactured of any convenient length and a plurality of sleeves is arranged along the length of the sections. The sleeves themselves may also be of any convenient length and are usually spaced apart a distance something less than the length of the sleeve although the spacing of such sleeves is a matter of choice.

Associated with each of sleeves 40 there is a control valve 42. The control valves 42 control admission of fluid to the sleeve and the draining of such fluid from the sleeve. The various fluid conduits for operating the sleeves are illustrated in Figure 2. The interconnections between the sleeve and the controlling valves will be discussed in association with the logic diagram, Figure 7.

As the section 12 illustrated in Figure 2 is intended to be the first section of the pump which is attached to the tank 14, this section contains an initiation valve 44. The initiation valve 44 commences the squeezing operation of a first one of the sleeves 40. In operation successive sleeves 40 each begin to squeeze the flexible conduit 26 after squeezing has been commenced by the next adjacent upstream sleeve. The initiation valve 44 also commences the sequential releasing

of each of the sleeves so as to permit additional material to be pumped to flow into the area surrounded by the sleeve 40.

The sleeve 40 is shown in greater detail in Figures 3 and 4. In the preferred embodiment of the invention illustrated the sleeve 40 comprises a pair of backing plates 46 which surround the flexible conduit 26. Each backing plate 46 comprises a flanged portion at either edge which portions are adapted to receive a plurality of bolts 48. The backing plates 46 are bolted together by means of bolts 48 with a spacer 50 at either edge.

Figure 4 illustrates the sleeve in the condition when the flexible conduit has been squeezed shut. It will be observed that the spacers 50 space apart the backing plates so as to provide substantial flattening of the flexible conduit 26 without otherwise damaging the conduit.

The backing plates 46 serve as the support or anvil for a pair of inflatable bladders 52. The bladders 52 may comprise an elastomeric membrane 54 substantially fixed to the backing plate 46 and a second flexible membrane 56 which is held to the spacers 50 by the bolts 48. The flexible membranes 54 and 56 are joined together above and below the back plates and comprise between them a closed chamber 50 for the admission of fluid. Fluid is admitted to the chamber 58 by a T-fit-

ting 60 which passes through the backing plate 46 and through membrane 54. Upon admission of fluid to chamber 58 the flexible membrane 56 will be forced against the wall of the flexible conduit 26 and when the pressure in the chamber is sufficient, will collapse the conduit so as to expel any material within the flexible conduit from the area of the sleeve. The backing plates 46 need be strong enough only to support the inflatable bladder 52 for such squeezing activity. The plates may be manufactured of any suitable material of sufficient strength including metal, fiberglass reinforced plastic or the like. The two T-fittings 60 are interconnected by a tube 62 so as to ensure that the same pressure is created in each of the chambers 58 of a single sleeve 40. Tube 62 is also equipped with a third T-fitting 64. The T-fitting 64 is utilized to drain the fluid from the chambers 58 in the appropriate sequencing.

The basic principle of the operation of the pump is more easily grasped by assuming that the flexible conduit 26 is full of concrete and the pump is not running. That is to say, there is no fluid in any of the chambers 58 of the various sleeves 40.

Upon initiation of the pumping means the first sleeve 40 is caused to receive fluid from a source of fluid under pressure. The fluid is admitted to chambers 58 causing the inflatable bladders 52 to expand and thereby collapse the portion of the flexible conduit 26

surrounded by that first sleeve 40. Any material such as concrete or the like located within the flexible conduit adjacent the first sleeve 40 will be forced to move along the conduit in a downstream direction. Accordingly, an amount of concrete equal to the volume of the conduit squeezed will be caused to move along flexible conduit 26.

The next sequence in the pumping action is the feeding of pressurized fluid to the chambers 58 of the next succeeding down stream sleeve 40. As the inflatable chambers of the next down stream sleeve 40 expand, concrete or the like within the flexible conduit 26 adjacent the second sleeve 40, must also move along the conduit. At this stage if the first sleeve is still in the inflated condition, that is to say, the flexible conduit 26 has been collapsed then any material acting under the effect of the collapse of the second such sleeve 40 will be caused to move further in the down stream direction, that is to say in the direction of desired flow.

A third sleeve 40 adjacent the second such sleeve is then commenced to similarly receive pressurized fluid and cause a squeezing of the flexible conduit. As long as the second such sleeve 40 remains in the collapsed state while the third sleeve is collapsing material will again be forced to move in the down stream direction. Once the third sleeve 40 has commenced to col-

lapse the flexible conduit 26, the source of pressurized fluid may be removed from the first such sleeve so as to prepare the first such sleeve for a second supply of material.

It will be appreciated that a section of the pump may be any particular length as may be convenient and the sequencing of the squeezing means will effectively force material along the flexible conduit 26. It has been found that a particularly suitable method of operating such a pump involves the releasing of a first sleeve in a sequence of sleeves upon pressurization of the fourth such sleeve. Thus, a signal can be generated to indicate that the fourth such sleeve is being pressurized and that signal is used to release the pressurizing fluid from the first such sleeve. Figure 7 illustrates a schematic diagram of a section according to the invention having six sleeves of the type illustrated in Figures 3 and 4. Each sleeve has its own control valve for controlling the admission and exhaust of pressurized fluid into the chambers 58. Figure 7 is a schematic illustration of the first such section of the pump according to the invention and accordingly a schematic initiation valve 44 is also illustrated.

For the purposes of Figure 7 it is assumed that the pump is being used to pump concrete upwardly. The control valve 42A controls the operation of sleeve 40A, control valve 42B operates the sleeve 40B and so on

through to control valve 42F which controls sleeve 40F. Control valve 42A is attached by means of suitable tubing to a source 70 of pressurized fluid. The source 70 is required to provide sufficient volume of fluid to act as the pumping medium. The source 70 may be a supply of compressed air or hydraulic fluid such as oil or water. It has been found in an experimental model built using compressed air as the operating fluid that a 25 per square inch gauge pressure is adequate to pump concrete through a flexible conduit having a nominal diameter of four inches. Each control valve 42 comprises a supply manifold port 71 which extends through the valve. These ports are interconnected by tube 72 to comprise a manifold to supply pressurized fluid. In Figure 7 this is shown at the extreme right of each valve 42.

Each valve 42 also comprises an exhaust manifold port 73 passing through the valve body. Control valve 42 is linked by suitable tubing to a drain at zero PSI gauge 74. Each of the control valves 42 are interconnected by tube 76 so as to provide a common manifold, all leading to the drain 74. In Figure 7 this is shown at the extreme left of each valve 42.

Adjacent to the port comprising the supply manifold port 71, each control valve 42 comprises a chamber supply port 75. This is linked by tubing 78 to the inflatable chamber 58. The chamber supply port 75 may be linked to the supply manifold line 72 on movement of a

spool valve within the control valve 42.

Adjacent the exhaust manifold port 73 each control valve 42 comprises a chamber exhaust port 77. The chamber exhaust port is linked to the chamber 58 by means of tube 80. The chamber exhaust port 77 may be linked to the exhaust manifold tube 76 internally of each control valve 42 upon movement of a spool valve.

The spool of the control valve 42 is operated by means of differential pressure on a spool member carried by the spool. Each such control valve 42 comprises a port 79 extending through the body of the valve to which is connected a supply of reference pressure air. The reference port 79 of each valve 42 is interconnected by means of tube 82 which then comprises a reference pressure manifold interlinking all of the control valves. The tube 82 is connected to a supply 82a of pressurized air. In the example illustrated, the reference air pressure is maintained at 15 PSI gauge. The reference pressure air acts on one side of the spool member.

Each control valve 42 comprises a trigger port 81 which communicates with the second side of the spool member.

A valve having such ports and an internally moving spool of this type are illustrated in Figures 5 and 6. In Figure 6 the spool has been moved to the right under the effect of the reference manifold pressure and has prevented communication between the supply

manifold port and the chamber supply port. At the same time the chamber exhaust port has been opened so as to connect with the exhaust manifold port. Accordingly, when the valve is in this position the chamber 58 will be connected to the exhaust manifold and will be in a deflated condition. In Figure 5 the spool is shown having moved to its left hand position under the influence of the pressure in the trigger port. When in this configuration the supply manifold port now communicates with the chamber supply port so that pressurized fluid from the source 70 will be communicated to the chamber 58. The chamber exhaust port has been sealed so as to not any longer communicate with the exhaust manifold port. Thus, pressure supplied from the source 70 will be communicated to the chamber 58 and will be held by the chamber as there is no exhaust from the chamber.

The valve body shown in Figures 5 and 6 may be cast in two halves. The various ports are most easily produced by through drilling of passages, threading the passages, and using the threaded hose fittings and plugs as required. The horizontal passage as shown in Figures 5 and 6 may be plugged at each end. One side of the chamber supply port and one side of the chamber exhaust port may also be conveniently plugged as shown.

When the pump is not working the reference supply pressure maintains the valve in the configuration illustrated in Figure 6. In order to operate the first

sleeve 40A pressure must be supplied to the trigger port 81A. Such pressure is provided by the operation of the initiation valve which will be subsequently explained. Upon supply of pressure to the trigger port 81A in excess of the reference pressure the spool will be caused to move to the left, that is to the position shown in Figure 5. The source 70 will then be in communication with the chamber 58A to commence inflation of that chamber. As long as the trigger pressure applied to control valve 42A remains in excess of the reference pressure the control valve 42A will isolate chamber 58A from the drain line and permit inflation of the chamber 58. Fluid will flow from the source 70 until chamber 58 is at the pressure of the source. As indicated previously the source is conveniently at a pressure of approximately 25 PSI.

From review of Figure 7 it will be appreciated that the chamber 58A is connected by tube 84B to the trigger pressure port 81B of control valve 42B. Therefore the trigger pressure at valve 40B will at all times be equal to the pressure in chamber 58A. Accordingly, as the chamber 58A starts from zero pressure the source will first inflate the chamber to the pressure of approximately 15 PSI. At this point it is presumed that the chamber will have substantially squeezed the flexible conduit 26. As the pressure in chamber 58A exceeds 15 PSI the trigger pressure at port 81B will exceed 15

PSI and the control valve 42B will open to interconnect the chamber 58B with the source 70 thus commencing inflation of chamber 58B. It will be appreciated that the chamber 58B does not begin to commence inflation until chamber 58A has exceeded the reference pressure of 15 PSI. Similar interconnection between sleeves 40B and 40C ensures that chamber 58C will not commence inflation until the pressure in chamber 58B exceeds 15. Thus, the valving system provides a sequential operation of the squeezing means 40 in the section.

Sleeve 40C is interconnected to sleeve 40D in a similar fashion so that the chamber 58D will commence inflation only when the chamber 58C has exceeded 15 PSI. Chamber 58D has one extra connection illustrated by tubing 90 which is connected to the initiation valve. The effect of this interconnection is that each squeezing means commences the squeezing of the conduit only after the next adjacent upstream squeezing means has squeezed the conduit.

Prior to discussion of the initiation valve the sequence of deflation should also be understood with reference to Figures 5, 6 and 7. When the trigger pressure in port 81A is removed from control valve 42A the spool will react under the reference pressure to move to the right to the position illustrated in Figure 6. At this time the chamber 58A is connected to the exhaust manifold port 73 and the pressure in chamber 58A will

begin to fall from 25 PSI to zero. Chamber 58A is interconnected as previously explained by tube 84 to the trigger port of control valve 42B. Thus, when chamber 58A has exhausted to the point where the pressure is less than 15 PSI the control valve 42B will then operate to commence draining of chamber 58B. Similarly, chamber 58C will commence draining when chamber 58B is less than 15 PSI and chamber 58D will commence draining when the pressure in chamber 58C is less than 15 PSI. Upon the draining of chamber 58D the pressure in the line 90 connecting chamber 58D to the initiation valve will also begin to fall and ultimately become zero. From this explanation it will be appreciated that the sleeves will commence draining in the same sequential fashion in which the sleeves were originally pressurized.

From review of Figure 7 it will be noted that the squeezing means 40E and 40F are interconnected in exactly the same fashion as the lowermost sleeves. The effect of the interconnection between sleeve 40D and the initiation valve does not in any way effect the operation and sequencing for either inflation or deflation of sleeves 40E and 40F.

In Figure 7 the intercommunications between sleeve 40F and the next adjacent downstream sleeve are illustrated as lines simply ending on the page. It is suggested that in manufacturing the pump of this invention the tubing of the final sleeve 40F will be equipped

with quick disconnect fittings in order that a second section 12 may be readily connected to the section illustrated. The sequential squeezing will then be passed on to the sleeves 40 of a second or subsequent section and the sequential squeezing of the flexible conduit 26 will proceed throughout the entire length of the conduit without the need of any further initiation valve or the like. The tubing outlets from the final squeezing means at the end of the pump are simply plugged.

The initiation valve 44 is similar in construction to the control valve 42 except that the interconnections to supply and drain are reversed. In the initiation valve 42 the reference pressure manifold port 79 is connected by tube 100 to the reference source of pressure at 15 PSI. The trigger port 81 is connected by tube 90 to the pressure in chamber 58D. In the initiation valve 44 the supply source 70 is connected to what in the normal course would be the exhaust manifold port 73 which is then plugged on one side. The port which corresponds to the chamber exhaust port 77 may be used for intercommunication between the supply pressure and line 84 which then acts as the trigger pressure for control valve 42A. Tube 84 is also connected to the port 71 otherwise used as the supply manifold port and the outflow from this port is also plugged. The port typically used as the chamber supply port 75 may then be connected by tube 104 to the drain 74.

The reference pressure tube 100 to the initiation valve 44 is equipped with a manual start valve 106.

When the air compressor is turned on to provide the source 70 at 25 PSI and the reference pressure at 15 PSI, the system is not operating if valve 106 is closed. Upon opening valve 106, the reference pressure is communicated to tube 100 which moves the spool of initiation valve 44 to the right in Figure 7 interconnecting the supply pressure 70 and tube 84. Supply pressure of 25 PSI is then communicated through tube 84 to the trigger port of control valve 42A. This will then commence inflation of chamber 58A. The inflation sequencing will be continued through to chamber 58D.

When chamber 58D is being inflated the pressure will rise above 15 PSI in tube 90. Once the pressure in tube 90 is above 15 PSI then the spool in the initiation valve 44 will move to the left in Figure 7 thereby removing the supply pressure from tube 84. At the same time the spool of the initiation valve 44 will interconnect line 84 with the drain 74 thereby relieving the trigger pressure in control valve 42A. This will commence the deflation cycle which will proceed sequentially through to chamber 58A. When the pressure in chamber 58D falls below 15 PSI the reference pressure in line 100 will cause a new initiation of the cycle automatically. Tube 90 thus provides the signal which determines the start of the deflation sequence. Tube 90 may eman-

ate from any squeezing means other than sleeves 40A or 40B but preferrably emanates from sleeve 40D as illustrated.

Thus, it will be observed that the system will operate providing automatic sequencing as along as the start valve 106 remains in the open position. Closing of the start valve 106 will result in the system ceasing to function.

It will be appreciated from review of the logic diagram that a pulse of squeezing will commence at the first sleeve 40 and pass along the entire length of the interconnected sections 12. Any concrete or the like in the flexible conduit 26 at the location of sleeve 40A will be pushed throughout the length of the conduit. When sleeve 40A is exhausted, sleeve 40D remains in the pressurized position having collapsed the flexible conduit 26. Thus as new material to be pumped flows into the vicinity of sleeve 40A there is no pressure in sleeve 40A resulting from whatever amount of concrete may be down stream. Thus, each sleeve 40 is required only to force the concrete the length of the sleeve and need develop only sufficient pressure to move the concrete or other flowable substance that distance.

The speed with which the pump sequences depends upon the speed at which the source of pressurized fluid can inflat the chambers to the desired pressure. The flow of air or other fluid through the control valves is

governed not only by the capacity of the source 70 but also by the bores of the ports within the valves and the diameter of tubing used. In the experimental model built using the logic diagram illustrated in Figure 7 it was found that pressure waves passed along the collapsible conduit at the rate of approximately one per second and thus at the outlet the pump appeared to give virtually continuous but pulsating flow of concrete. It will be understood that with the mechanism of this pump, concrete and the like is not vibrated and thus there is no limit on the length through which the concrete may be pumped. In addition, because each portion of concrete being squeezed is not effected by the portion substantially down stream, there is no vertical limit on the height to which the concrete may be pumped. It is believed that with a pump of this construction, it would be possible to pump concrete to any desired height to which a skyscraper may be constructed.

Referring now to Figures 2, 3 and 4 it will be observed that the section comprises an outer casing 20. The casing 20 serves to enclose the sleeves 40, the control valves 42 and the initiation valve 44 together with all of the tubing interconections. Casing 20 may be constructed of a relatively rugged flexible material such as spiral wire reinforced rubber and the like. Each section will be of considerable weight depending upon the length of the section. These sections may be

bolted together as required. It is believed that it would be most convenient to provide the flexible conduit 26 and the various tubing connections with quick disconnect connectors to facilitate the linking together of a plurality of sections. If the casing is manufactured of a flexible wire reinforced material then the entire section will be flexible and may be bent to provide whatever curve or location is required.

In order to support the section under its own weight and the concrete carried by the section it is advantageous to provide a wire rope interconnection between the various sleeves. This is shown in Figures 2 and 3.

Wire rope 120 extends through the head of one or more of the bolts 48. Two such wire ropes are shown, one at each flange of the backing plates 46. The wire rope may be wound about the bolts 48 or otherwise crimped within the head of bolt 48 after the bolt has been tightened in place so as to provide support for the sleeve 40. The wire ropes 120 are fixed to the casing flange 22.

The wire ropes which may be at the order of 1/16" diameter provide a support connection between the sleeves 40 and the casing flange 22. In this way the flexible conduit 26 is also supported.

Where a plurality of sections are to be bolted together to form a vertically extending pipe, then each

section will have to carry the weight of all sections below and their contents unless separately supported. For this purpose, it is suggested that the flanges 22 and 24 of each section be fixed together by a plurality of heavy wire ropes. A useful configuration is the use of 4-3/16" nominal diameter wire ropes extending between the flanges. Four such ropes will support a useful column of sections.

In Figure 1, for simplicity purposes, the pump 10 is shown supported by a plurality of support plates 18 arranged at each floor of the building under construction. Utilization of the wire rope interconnection as explained above provides that each section can carry its own weight as well as the weight of several section below. Where the pump is being used on a very tall building such as 10 or more stories, it may be considered advisable to support each of the individual casing flanges. Each section could conveniently be made approximately 10 to 12 feet long to correspond to the height of a single story. Where the building under construction is relatively lower of the order of 8 to 10 stories, then the entire pump 10 may be supported from a single overhead support. The overhead support may be attached directly to the building 16 or may comprise support provided by a ground supported crane or the like.

It will be appreciated that a squeeze pump of

this type does not develop significant vaccuum. Some vaccuum is developed by the action of the breaded hose flexible conduit 26 returning to its natural open configuration as chambers 58 are released. However, this is not likely useful to generate a "suction" head to the pump. For this reason the hopper 14 shown in Figure 1 is kept relatively filled with concrete so as to force concrete into the first few sleeves of the pump 10.

While the invention has been discussed fully with respect to a preferred embodiment having a specific valve and sequencing arrangement, the same operating principle can be achieved with different valving. It is not necessary to provide a separate valve for each sleeve. A single rotary valve may be used having appropriate connections for a plurality of sleeves. Various other types of initiating valves may also be used. Similarly, electrically signalled valves may be used in place of the hydraulically operated valves illustrated.

While the invention has been described in association with a particular preferred embodiment it is believed that those familiar with this art will realize that various changes or modifications may be made to the invention without departing from the scope of the invention as defined in the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A pump for moving a flowable substance along a flexible conduit comprising:

a plurality of squeezing means arranged adjacent one another along the conduit;

said squeezing means adapted to squeeze said conduit each said squeezing means having a fluid inflatable chamber surrounding said conduit,

initiating means to initiate squeezing of said conduit by a first squeezing means,

sequencing means to cause successive squeezing means to squeeze said conduit so that a flowable substance is conveyed along said conduit by the squeezing of said conduit,

valve means for controlling flow of pressurized fluid to said inflatable chamber and exhaust of said fluid from said chamber and

signal means to generate a signal indicative of inflation of the chamber of one of said sleeves, and means responsive to said signal to cause exhaust of pressurized fluid from the first of said sequential sleeves, said signal being generated by any sleeve other than the sleeve next adjacent said first sleeve and said first sleeve.

2. A pump according to claim 1 having at least four sequentially arranged sleeves, said signal being generated by the fourth sleeve.

3. The pump of claim 1 said pump comprising a plurality of sections each section comprising a casing enclosing said flexible conduit and said squeezing means, said casing having first and second casing flanges for joining together a plurality of said casings to comprise a pump of extended length.

4. The pump of claim 3 said segment further comprising wire rope reinforcing means extending between said flanges, said wire rope fixed to a plurality of sleeves.

5. The pump of claim 4 wherein said squeezing means comprises a support backing having at least two support plates and said inflatable chamber comprises at least two flexible fluidly interconnected chambers.

6. The pump of claim 1 wherein said sequencing means comprises a plurality of valves at least one for each squeezing means, each said valve controlling a supply of pressurized fluid to said inflatable chamber and a drainage of pressurized fluid from said inflatable chamber.

7. The pump of claim 6 wherein the valve controlling a squeezing means controls the supply of pressurized fluid to the inflatable chamber of said squeezing means to commence supply of pressurized fluid subsequent to the commencement of supply of pressurized fluid to the adjacent upstream squeezing means.

8. The pump of claim 7 wherein said valve comprises a housing, a port for inlet of pressurized supply fluid and a port for inlet of a reference pressure fluid, a spool member

having first and second sides, said reference pressure fluid acting on one side of said spool member to move said spool to prevent fluid communication from said pressurized supply fluid to said inflatable chamber.

9. The pump of claim 8 said spool member having a trigger pressure fluid applied to the second side of said spool member, said trigger pressure fluid when greater than said reference pressure causing said spool to move to a position to permit fluid communication from said pressurized supply fluid to said inflatable chamber.

10. The pump of claim 9 wherein the pressure of said trigger pressure fluid for a valve other than a first squeezing means is the pressure of the inflatable chamber of the adjacent upstream squeezing means.

1217386
4-1

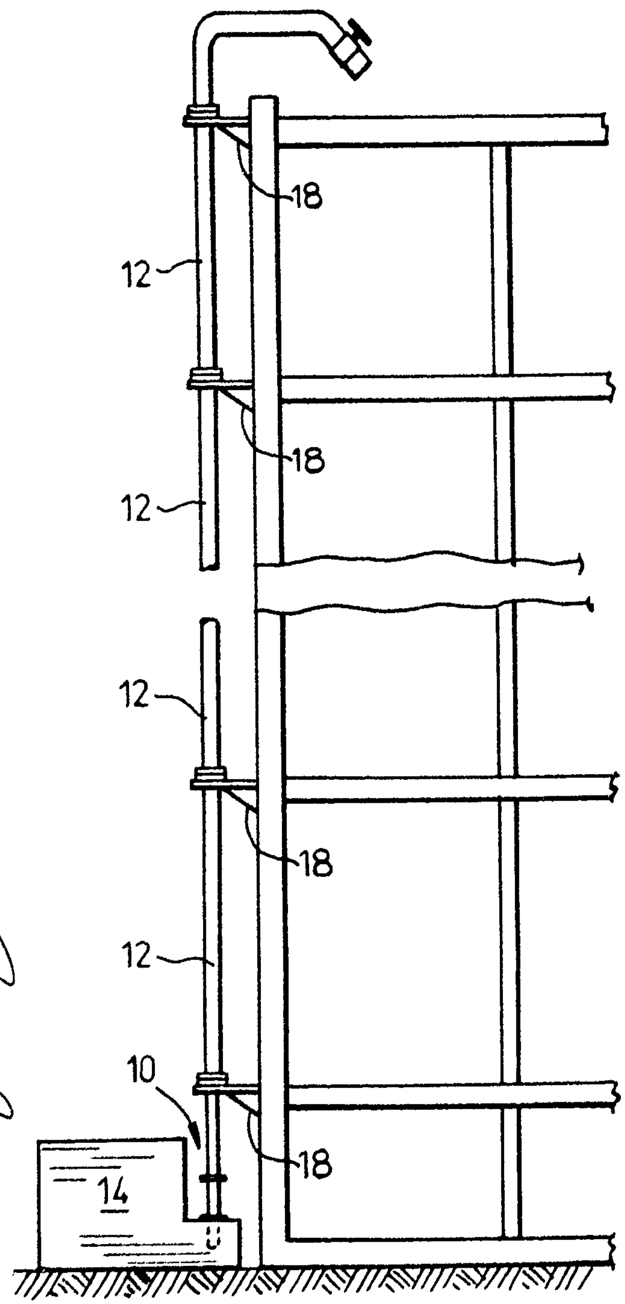

FIG. 1

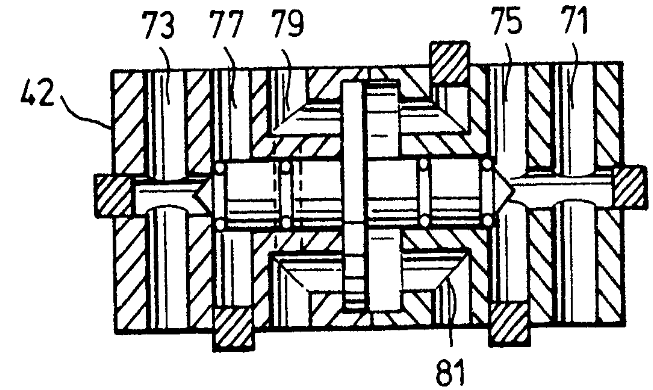

FIG. 5

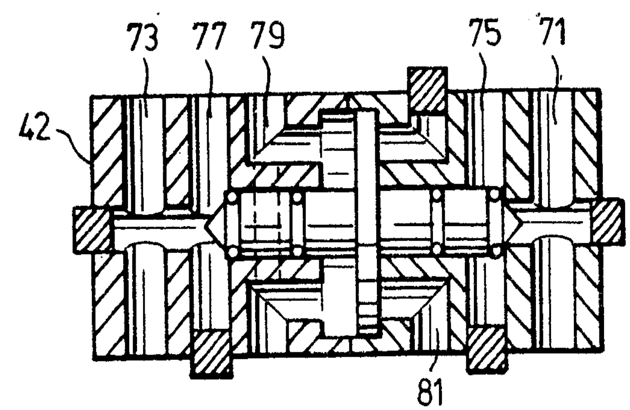

FIG. 6

Rogers Bereskin & Parr

1217386

4-2

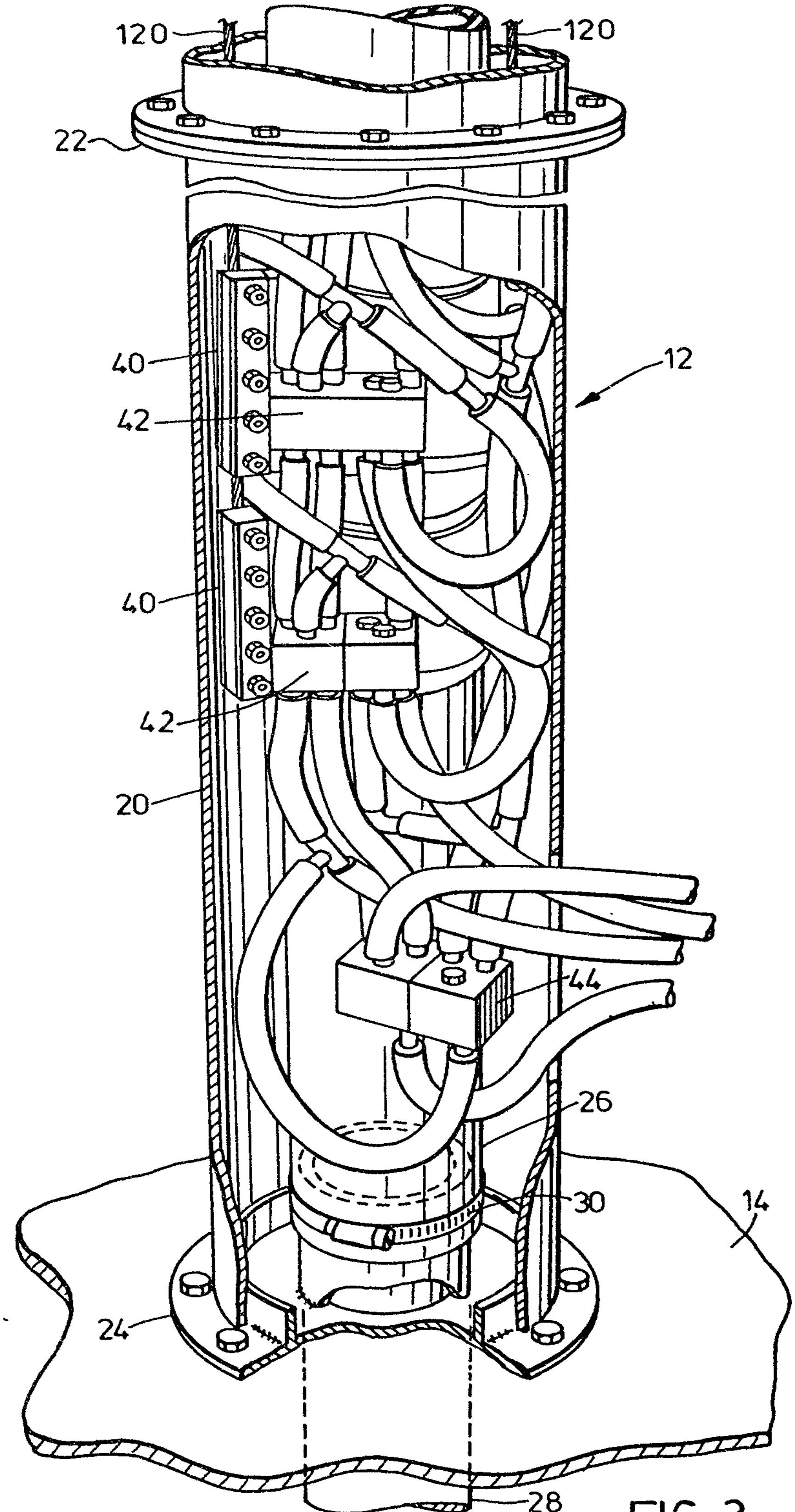

FIG. 2

Rogers Bereskin Parr

1217336

4-3

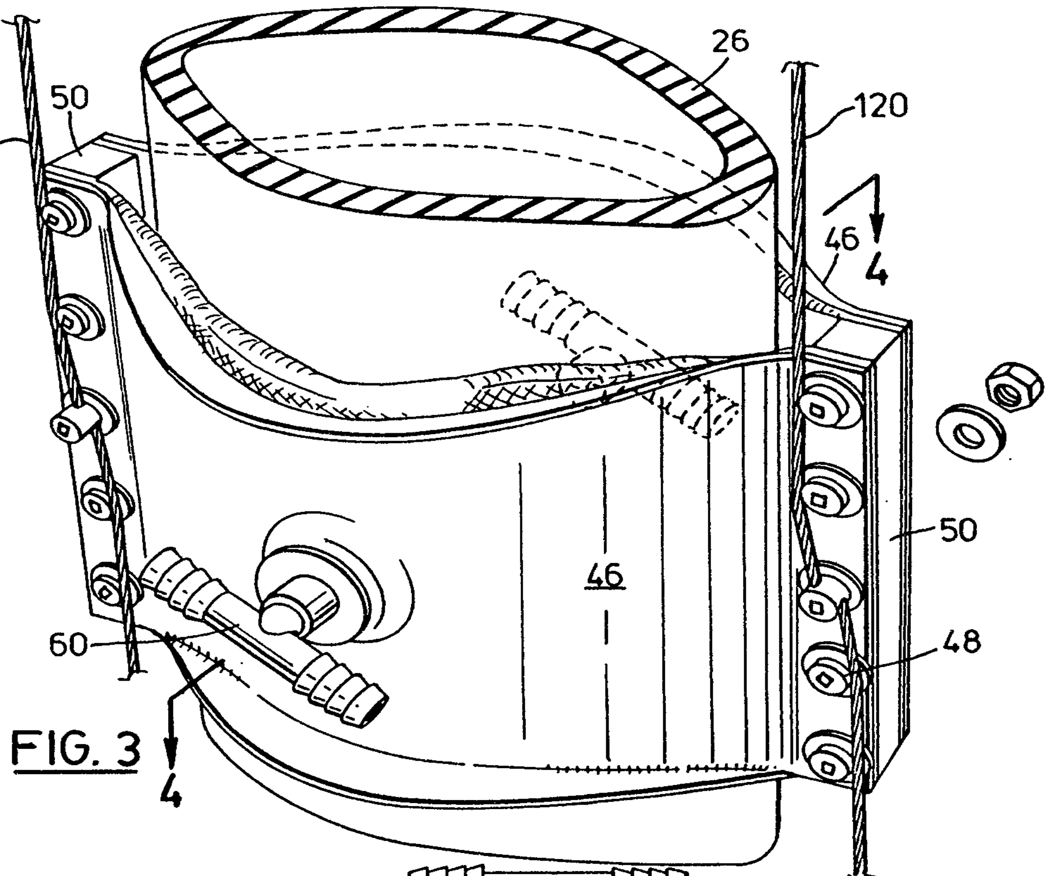

FIG. 3

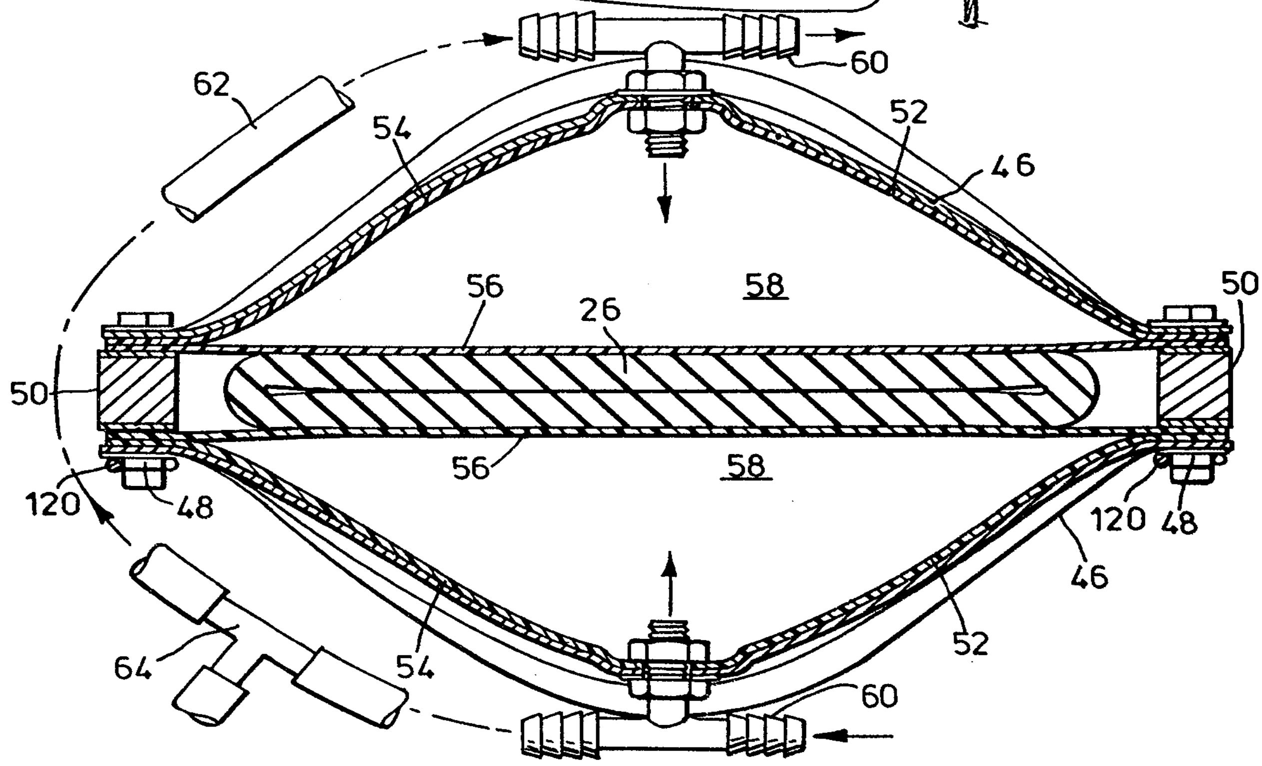

FIG. 4

1217386

4-4

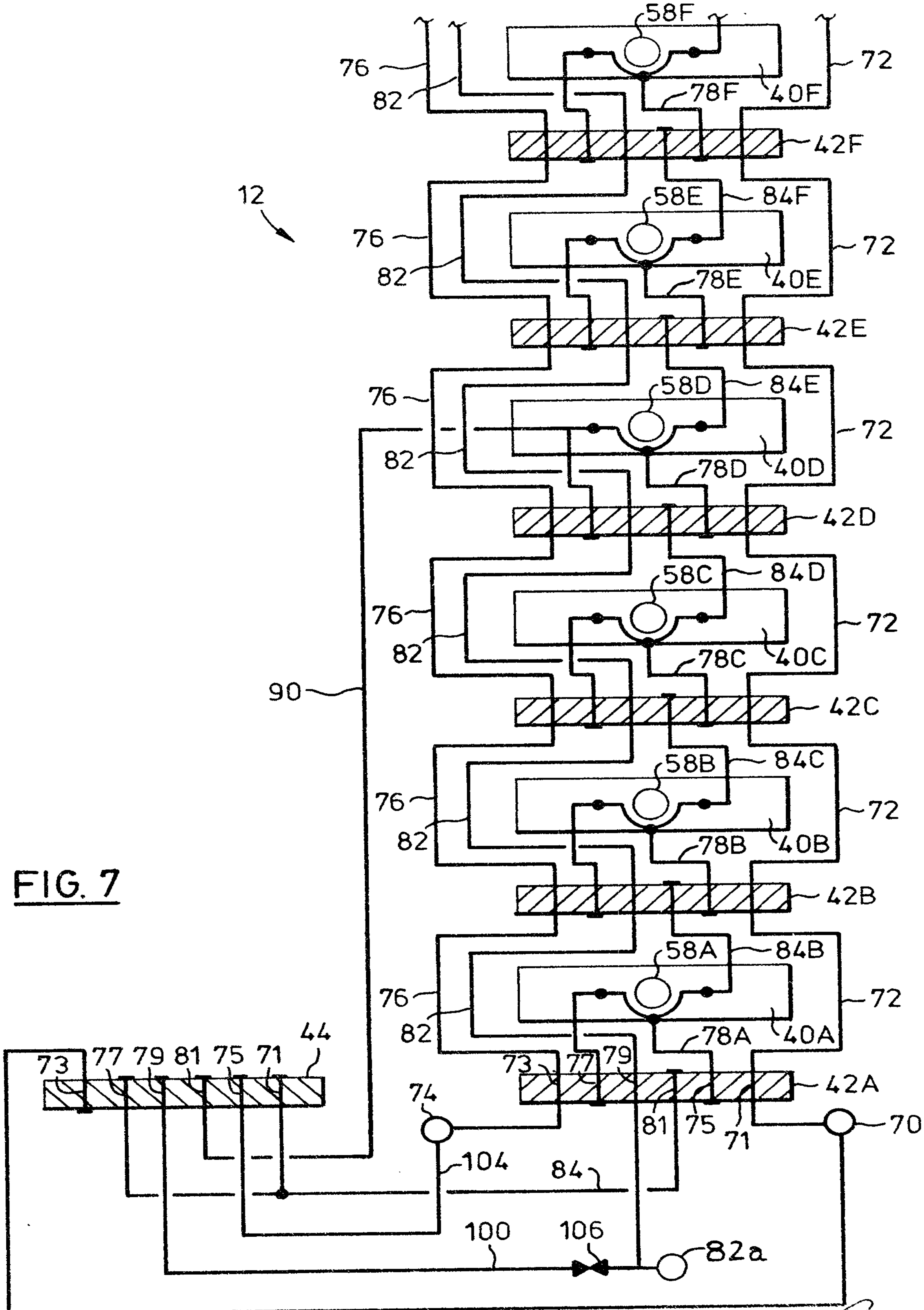

FIG. 7

Roger Berekin Jan

DERWENT-ACC-NO: 1987-072876

DERWENT-WEEK: 198711

TITLE: Pump moving e.g. concrete along flexible conduit has adjacent squeezing assemblies with inflatable chambers surrounding conduit, with sequencer and control valve

INVENTOR: ZELENKA F

PATENT-ASSIGNEE: ZELENKA F[ZELEI]

PRIORITY-DATA: 1984CA-460902 (August 13, 1984)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
CA 1217386 A	February 3, 1987	EN

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
CA 1217386A	N/A	1984CA-460902	August 13, 1984

INT-CL-CURRENT:

TYPE	IPC DATE

CIPS	F04B43/10 20060101
CIPS	F04B43/113 20060101
CIPS	F04B43/12 20060101

ABSTRACTED-PUB-NO: CA 1217386 A

BASIC-ABSTRACT:

The pump comprises a number of squeezing assemblies arranged adjacent one another along the conduit to squeeze the conduit, each having a fluid inflatable chamber surrounding the conduit. An arrangement initiates squeezing of the conduit by a first squeezing assembly and a sequencing arrangement causes successive assemblies to squeeze the conduit so that a flowable substance is conveyed along the conduit. A valve is provided for controlling flow of pressurised fluid to the inflatable chamber and exhaust of the fluid from the chamber.

A signal is generated indicative of inflation of the chamber of the sleeves, and in response to the signal exhaust of pressurised fluid is caused from the first of the sequential sleeves, the signal being generated by any sleeve other than the sleeve next adjacent the first sleeve. There are pref. at least four sequentially arranged sleeves, the signal being generated by the fourth sleeve.

USE/ADVANTAGE - E.g. for handling concrete made of convenient length and strung together to accommodate any distance or height.

TITLE-TERMS: PUMP MOVE CONCRETE FLEXIBLE CONDUIT ADJACENT SQUEEZE ASSEMBLE INFLATE CHAMBER SURROUND SEQUENCE CONTROL VALVE

DERWENT-CLASS: Q56